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ABSTRACT

Two major hypotheses are currently at issue concerning the effects of semantic context on ambiguous word recognition: (1) the selective-retrieval hypothesis (SRH) maintains that a single meaning is retrieved from memory, and (2) the nonselective-retrieval hypothesis maintains that all meanings are retrieved from memory. To help clear up this controversy, the following experiment was undertaken. Subjects processed a sequence of three words in which the second word was ambiguous. When the first and second words were semantically related, a similar relation between the second and third words facilitated recognizing the third word, but a dissimilar relation did not. Apparently alternative meanings of ambiguous words are not accessed simultaneously. The data collected is in support of the SRH hypothesis. (Author/TL)

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Contextual Constraints on Ambiguous Word Recognition

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Abstract

People processed a sequence of three words in which the second word was ambiguous. When the first and second words were semantically related, a similar relation between the second and third words facilitated recognizing the third word, but a dissimilar relation did not. Apparently alternative meanings of ambiguous words are not accessed simultaneously.

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Ambiguity has provided the basis of a great deal of research and speculation in psychology. Reversible figures such as the Necker Cube and the Peter-Paul Goblet served Gestalt Psychology as compelling demonstrations of organizational processes in perception. More recently, ambiguous linguistic material has been used to study attentional processes, the nature of the memory trace, and sentence comprehension. While these studies have yielded many interesting findings regarding these problems, some fundamental questions remain about the processes involved in perceiving ambiguous linguistic stimuli.

Consider the recognition of an ambiguous word such as BANK. This word can refer either to the land beside a river or to a financial institution. When the word occurs in context we experience little difficulty determining the intended meaning of the word. However, there are several alternative views about how a single interpretation of an ambiguous word is derived. For simplicity, let's consider two contrasting hypotheses.

The selective-retrieval hypothesis (SRH) hold that only a single meaning of an ambiguous word is retrieved from memory in recognizing the word, and semantic context biases retrieval toward a particular interpretation. In contrast, the nonselective-retrieval hypothesis (NSRH) holds that all meanings of an ambiguous word are retrieved every time the word occurs, and semantic context does not bias retrieval toward one interpretation rather than another. Rather, contextual information is used after retrieval to select a particular meaning.

While several studies in the literature have used ambiguous words as stimuli, only a few experiments have been designed to study the processes which occur at the time an ambiguous word is recognized. For example, Foss and Jenkins required subjects to listen for a particular phoneme in an aurally presented sentence. They found that more time was required to signal the occurrence of the phoneme when it followed an ambiguous word than when it followed an unambiguous word. The greater difficulty of processing the ambiguous word was not affected when the prior context in the sentence was related to one meaning of the ambiguous word. Foss and Jenkins inferred that ss always retrieved both meanings of the ambiguous word regardless of prior context, thereby leaving less processing capacity for detecting the subsequent phoneme. Thus, Foss and Jenkins rejected the selective-retrieval hypothesis in favor of the nonselective retrieval hypothesis. Using a variation of the Stroop color-word task, Conrad found evidence that both meanings of ambiguous words are activated regardless of the constraints imposed by prior context. She, too, concluded that the nonselective-retrieval hypothesis is correct. One problem with both of these studies is that the manipulation of context failed to produce effects. It is possible that the manipulations were simply not strong enough.

Over the past few years, Dave Meyer and I, in collaboration with colleagues at Bell Laboratories and Stony Brook, have been studying the effects of semantic context on word recognition. Our basic procedure consists of presenting strings of letters for subjects to judge as words or nonwords by pressing one of two response keys. In a variety of experiments using a variety of stimulus materials, we have consistently found that responses to words in this task are facilitated in the context of a semantically related word. For example, responses to the word NURSE are faster when DOCTOR has just been judged than when an unrelated word such as LAMP precedes NURSE.

When words are presented successively, the magnitude of this facilitation effect ranges between 35 and 45 msec. Several lines of evidence have led us to the conclusion that this semantic context effect occurs in the process of encoding words rather than in some other process involved in the task. For example, when the words are degraded, semantic context has an even greater effect than it does with clear stimuli. This suggests that semantic context assists in cleaning-up the "noise" in a degraded stimulus. As another example, we found that the presence of a related semantic context eliminated the interference which occurred when physically similar words were presented in succession. Thus, with our own work suggesting that semantic context is intimately involved in recognizing words, we found the suggestion that semantic context does not influence the processing of ambiguous words rather surprising. Thus, we decided to investigate the problem. We reasoned that the sensitivity of our procedure to semantic context effects could be used to assess the semantic processing of ambiguous words. By extension from our earlier work, the semantic processing of ambiguous words should be reflected in the processing of subsequent words. In addition, we manipulated the context in which an ambiguous word occurred by the relation between the ambiguous word and the word which preceded it.

The first slide shows the procedure we used. On each of 90 trials in the experiment, the subject classified three successive letter strings by pressing one of two response keys. The first letter string appeared following a 750 msec. warning signal--In this example, the word JELLY. The subject responded to the first letter string (in this case, a word classification would be correct). Immediately after the response to the first letter string the second letter string (TROBE in the example) appeared. The subject responded to the second letter string (a nonword, in this case) and the third letter string was presented (for example, the word LIGHT). The response to the third letter string terminated

the display, and a 2 sec. intertrial interval followed.

Triples consisting of all possible combinations of words and nonwords were presented in the experiment. However, we are primarily interested in the data from trials where three successive words were presented.

The next slide shows how these word triples were arranged. There were six types of word triples. In each triple, the middle word was always ambiguous. For example, BANK has both a financial and a geographical meaning, DATE has a meaning related to food and a meaning referring to a point in time. The six triples differed in the relations between the second word and the first and third words. The assignment of stimulus materials was such that each subject saw six triples of each type. A particular word was seen only once by each subject. Across subjects the words were counterbalanced so that each word appeared equally often in each condition. All of the relations among words involved both meanings of the ambiguous words equally often.

Now let's consider the stimuli in the light of the two hypotheses I mentioned earlier. Recall that the selective-retrieval hypothesis holds that only one meaning of an ambiguous word is involved in recognizing the word and that semantic context biases the interpretation. The nonselective-retrieval hypothesis says that both meanings of the ambiguous word should be involved in recognizing the word, regardless of prior context.

In the first type of word triple, the concordant associates, the first and third words are related to the same meaning of the ambiguous second word. For example, SAVE and MONEY are both related to the financial interpretation of BANK. Both hypotheses predict that we should observe facilitation in processing the third word (for example MONEY) here. The SRH because the first word biases recognition of the ambiguous second word toward the meaning which is related to the third word.

The NSRH predicts facilitation because both meanings of the ambiguous second word are retrieved and one of these meanings is related to the third word. In addition, as we have found in earlier work, responses to the third word could also benefit from the relation between the first and third words in concordant associates.

In the second type, discordant associates, the two hypotheses make different predictions. In the discordant associates, the first and third words are related to different meanings of the ambiguous second word. For example, RIVER is related to the geographical meaning of BANK while MONEY is related to the financial meaning. The SRH predicts that there should be no facilitation in processing the third words here. This is because the first word biases the interpretation of the second word toward a meaning which is unrelated to the third word. In contrast, the NSRH predicts some facilitation on the third word in discordant associates. Since both meanings of the ambiguous word are retrieved regardless of context, the meaning which is related to the third word should produce facilitation in recognizing the third word.

The initial associates provide a control condition for evaluating the effects in concordant and discordant associates. In the initial associates, the first two words are related as in the concordant and discordant associates but the third word is neither related to the first word nor to either meaning of the second word. For example, FIG is related to the food interpretation of DATE, but MONEY is relatively unrelated to FIG and to both the food and the point in time interpretation of DATE.

The terminal associates and the separated associates provide for further evaluation of the effects that occur in the concordant and discordant associates. The terminal associates involve a relation between the third word and one meaning of the ambiguous second word. For example, MONEY is related to the financial

interpretation of BANK, but FIG is neither related to MONEY nor to either meaning of BANK. These triples provide an estimate of the effect of an ambiguous second word on recognizing a following word related to one meaning of the ambiguous word when context does not bias the interpretation of the ambiguous word.

The separated associates provide an estimate of the effect of a relation between the first and third words. SAVE is related to MONEY, for example, but neither is related to DATE.

Finally the nonassociates provide a control for the terminal and separated associates. In the nonassociates, all three words are relatively unrelated. In particular, the first two words are unrelated as they are in the terminal and separated associates. Thus we can evaluate the effects in the terminal and separated associates by comparing them to nonassociates.

Before turning to the results for the third words in the triples, notice that we can use the data from responses to the second words in the triples to determine whether semantic context affects the recognition of ambiguous words. In the concordant, discordant, and initial associates, the ambiguous word is preceded by a word related to one of its meanings. In the other triples, the first word is unrelated to either meaning of the ambiguous word. Responses to the ambiguous word were reliably faster when a related word precedes. Thus our experiment, unlike the ones discussed earlier, shows that semantic context does influence the processing of ambiguous words. Now let's turn to the data for the third words in the triples. These data are shown in the next slide.

First look at the data for discordant associates where the two hypotheses make contrasting predictions. Consistent with the prediction of the SRH, discordant associates show no facilitation in processing the third word. Responses were slightly slower than in the control condition. This finding

is contrary to the expectation of the NSRH, and it suggests that the meaning accessed for the ambiguous word is the one consistent with the first word. The other meaning shows no evidence of having been accessed.

The conconcordant associates show that facilitation does occur in processing the third word. Also if we subtract the facilitation found for separated associates (22 msec.) from the facilitation found in conconcordant associates (46 msec.), we find that concordant associates produce reliably more facilitation than do separated associates. Thus the ambiguous second word facilitates recognizing the third word in concordant associates.

Finally, look at the terminal associates. The facilitation here was somewhat small and relatively variable. While this could suggest that in the absence of a biasing context ambiguous words never facilitated recognizing the third word, this result is also quite in line with what we might expect from the SRH. If only one meaning of the ambiguous word is retrieved on each trial, then this meaning would be related to the following word on about one-half of the trials. This should produce rather small amounts of facilitation, and the facilitation should be rather variable. Seventeen msec. is roughly half of the facilitation we ordinarily observe in comparable experiments with relatively unambiguous words. Thus this finding is not surprising from the perspective of the SRH.

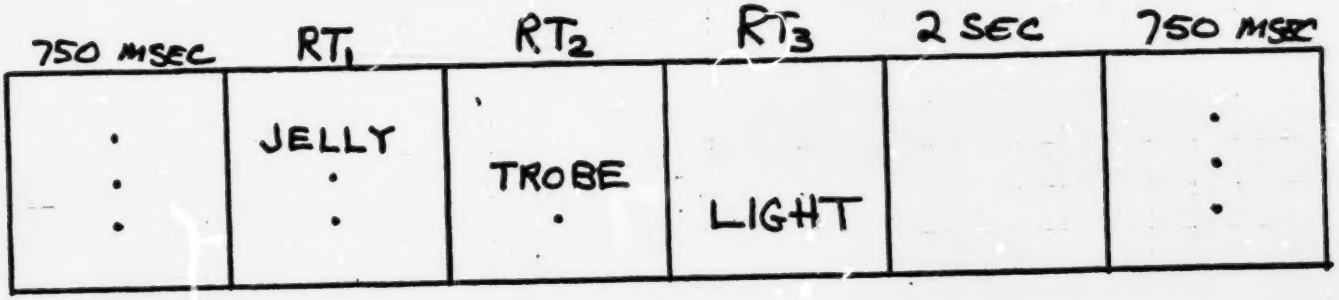
These findings give new life to the SRH. As in our earlier work, semantic context seems to be involved in the encoding of words in the sense that encoding is guided by the prevailing context. Naturally we have examined the earlier studies for clues about the apparent discrepancies in the findings. I have already mentioned that the manipulation of context may have been too weak in the earlier studies. There are also other differences such as the time available for processing ambiguous words and the overall task contexts. Further research is required to identify the source of the discrepancy.

Let me very briefly consider how our findings might be explained by models of word recognition. One class of models can be identified as passive models. The logogen model proposed by Morton is a familiar example. In these models recognition is based on an accumulation of features extracted from the stimulus until a logogen has counted sufficient features to reach threshold. Semantic context serves to decrease the amount of sensory evidence required to exceed threshold for logogens related to the context. This model can explain our results if we assume that there are distinct logogens corresponding to each meaning of an ambiguous word, and, further, that the first logogen to exceed threshold prevents other logogens from exceeding their thresholds also.

Now consider a class of active models. In active models, recognition is based on comparing stored prototypes of words with a sensory representation of the stimulus. Semantic context in these models affects the priority of the stored prototypes in the comparison process. These models can explain the selectivity we observed by assuming that the first prototype to produce a match terminates the comparison process.

Both active and passive models are capable of explaining the present evidence for selective semantic processing of ambiguous words. Of course, there are circumstances where the context, broadly defined, includes a set to retrieve multiple meanings of words. Punning represents a familiar if somewhat painful example of a play on multiple meanings. In the sense that alternative meanings can be retrieved when context requires it, apparent support for the nonselective retrieval hypotheses may result. Our findings suggest, however, that alternative meanings are not automatically retrieved regardless of context.

PROCEDURE - EXP. I



TYPE OF WORD TRIPLE	EXAMPLES
Concordant Associates	Save-Bank-Money River-Bank-Shore
Discordant Associates	River-Bank-Money Save-Bank-Shore
Initial Associates	Fig-Date-Money Time-Date-Shore
Terminal Associates	Fig-Bank-Money Time-Bank-Money
Separated Associates	Save-Date-Money River-Date-Shore
Nonassociates	Choose-Date-Money Shovel-Date-Shore

RESULTS - EXP. I

TYPE OF WORD TRIPLE	EXAMPLE	$\overline{RT}$	PERCENT ERROR
Concordant Associates	Save-Bank-Money	505	1.5
Discordant Associates	River-Bank-Money	558	2.1
Initial Associates	Fig-Date-Money	551	3.5
Terminal Associates	Fig-Bank-Money	521	2.9
Separated Associates	Save-Date-Money	516	4.3
Nonassociates	Choose-Date-Money	538	4.3

RESULTS - EXP. I

IPLE	EXAMPLE	RT	PERCENT ERROR	RT COMPARISON
ciates	Save-Bank-Money	505	1.5	46±8
ociates	River-Bank-Money	558	2.1	-7±12
tes	Fig-Date-Money	551	3.5	
ates	Fig-Bank-Money	521	2.9	17±15
iates	Save-Date-Money	516	4.3	22±11
	Choose-Date-Money	538	4.3	